A Strategic Plan for the Argonne Tandem Linac Accelerator System

Physics Division
Argonne National Laboratory

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Introduction

This strategic plan was developed jointly by the ATLAS user community and the Physics Division at Argonne National Laboratory. The community discussed and endorsed this plan at the July 31 – August 1 user workshop held at Argonne.

This plan provides the scientific and strategic vision for ATLAS, the goals for its future capabilities and the expected path forward in light of budget constraints.

This plan is available to the entire ATLAS user community and will be updated as the need arises.

Strategic Plan

Mission:

The mission for the ATLAS facility at Argonne is to enable research of the highest quality by its users and staff, especially probing the properties of atomic nuclei, through utilizing the capabilities of the accelerator and research equipment in a safe and efficient manner, with the associated responsibility of research and development in accelerator science and in the techniques that are required to accomplish its scientific goals.

This mission requires identifying the highest priority scientific goals, and allocating resources to optimize the research output of the facility. The current scientific goals are fully consistent with those defined in the NSAC 2002 Long Range Plan and the Office of Science 2004 Strategic Plan. The optimization of the research involves the following elements:

1. Effective long-term operation of the accelerator.
2. Development of new accelerator capabilities to enable new high priority research opportunities.
3. Effective support of the experimental program.
4. Development of new experimental capabilities to enable new high priority research opportunities.
5. Nurturing the scientific and technical base of the low energy research program and helping to develop the high-quality workforce for future initiatives.

This last element is not discussed explicitly below but is a major factor in the delivery of the entire research program, including the need for young researchers to be involved in equipment development and new research initiatives.

The major scientific goals of the ATLAS research program are: (a) understanding the stability and structure of nuclei as many-body systems built of protons and neutrons bound by the strong force, (b) exploring the origin of the chemical elements and their role in shaping the reactions that occur in the cataclysmic events of the cosmos, (c) understanding the dynamics governing interactions between nuclei at energies in the vicinity of the Coulomb barrier, and (d) testing with high accuracy the fundamental symmetries of nature by taking advantage of nuclei with specific properties.

To reach these goals, major research topics as identified by the scientific community, the Program Advisory Committee and the laboratory include:

- the development of beams of short-lived isotopes and their subsequent use for measurements of astrophysics interest and for nuclear structure and reaction studies;
- the production and characterization of nuclear structure away from the valley of stability including nuclei at the very limits of stability, i.e.; nuclei at and beyond the proton drip-line, on the neutron-rich side of the valley of stability, and in the region with $Z > 100$;
- the study of the nature of nuclear excitations as a function of mass, proton or neutron excess, spin and temperature: characteristics such as nuclear shapes, the interplay between degrees of freedom, and changes in shell structure;
- the use of traps for high precision mass measurements for astrophysics and for searches of physics beyond the standard description of the weak interaction.

Smaller scale, complementary efforts exploit the exceptional and often unique capabilities of ATLAS: for example, the irradiation of samples for materials research, developing accelerator mass spectrometry techniques for applications in environmental studies, oceanography, astrophysics, fundamental interactions, and any other area of basic science where they apply, and accelerator research experiments.

As ATLAS is presently the only low energy national user facility focusing on experiments with stable beams, there is an inherent responsibility to make stable beams available to the national community. However, the priorities expressed in the Office of Nuclear Physics performance measures and strategic plan, as well as the scientific goals given above, make it imperative that opportunities with unique radioactive beams at ATLAS continue to be pursued when identified as being important science by the community and endorsed by the Program Advisory Committee as high priority.

The optimal strategic plan to meet these goals and the mission of ATLAS incorporates the following primary elements:

1. Effective operation of the ATLAS facility at 7 days/week, 5500 – 6000 hours/year: this is a necessary condition to address (a) the large demand for low cross section experiments and for the detection of rare events, (b) the need of a large user community for flexibility in scheduling and operations, and (c) the need to develop new beams, especially exotic beams, and novel instrumentation.

2. The development of new accelerator capabilities targeted towards these scientific goals:
    a) The energy upgrade of ATLAS: the 30% increase in the maximum energy for ions in the 100-200 mass range is an essential ingredient of a research program probing nuclear states via transfer reactions in inverse kinematics with stable and rare isotopes in the 10 MeV/u range, where the velocities of the nucleons of interest in the projectile and target are well matched.
    b) The improvement of in-flight radioactive beams capabilities. This includes the installation of an RF chopper for the in-flight beam program to improve the beam purity for these short-lived, low-intensity beams and enable measurements of lower cross section for nuclear astrophysics.
    c) A major upgrade of the reaccelerated radioactive beam capability. The implementation of the so-called "Cf source upgrade" to provide neutron-rich species in the pre-RIA era that are not available elsewhere represents an important, unique step in the exploration of neutron-rich nuclei.

3. Effective support for experimental installation and operation. This includes:
    a) The required scientific and technical support for the user program.
    b) The continued operation of Gammasphere at ATLAS for the foreseeable future: much of the structure program requires the detection of gamma-ray events with large multiplicity for which the array was designed. Until the first tracking arrays become available, Gammasphere will remain the most powerful gamma-ray spectrometer available anywhere and it is essential that it be maintained in optimal operating condition.
    c) Continued development of the target production capability to meet the needs of the scientific program.
    d) Upgrade of data acquisition, analysis and networking capabilities to replace currently unsupported hardware and software.
    e) Experimental support for radioactive beam development

4. Continued development and operation of experimental capabilities. This includes:
    a) Complete the development of the Advanced Penning Trap and continue to exploit the Canadian Penning Trap.
    b) The construction of the X-array: this high resolution, high efficiency array for the focal plane of the FMA is an essential component for the decay spectroscopy of evaporation residues produced with sub-microbarn cross sections such as very heavy nuclei or proton emitters.
    c) The development of the high acceptance superconducting solenoid: this instrument represents an optimized solution to the challenge of measuring transfer reactions in inverse kinematics at all relevant scattering angles.

The strategic plan outlined above is optimized with the objective of best meeting the scientific goals and mission of the ATLAS facility. It is, however, workable only if funding increases significantly above the level of the FY 2004 budget. In the event that such resources do not become available, as is the case in the FY2005 Presidential budget,

all aspects of the strategic plan will be curtailed. This includes a reduction in accelerator operations.

It is the view of the user community and of the management of the Physics Division that 7 days/week operation of ATLAS at all cost is the wrong approach, even under scenarios with somewhat improved funding, and that a return to this desired level of operations is warranted only if investments in the maintenance and upgrade of the accelerator and the associated instrumentation can be made. This approach will help realize the potential of the science for the low-energy community by assuring the long term future of operations at ATLAS.